Journal of Food Distribution Research
Volume 52, Issue 2, pp. 76-100

# Low-Income Household Food Consumption Consequences of Rice Policy and Pandemic Impacts on Income and Price in Thailand

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## Abstract

Using Thai household data, we estimated a demand system and analyzed the impacts of changes in rice prices and household income on food consumption, then used these results in four experiments. We found that a trade policy that attempts to reduce domestic prices benefits households in the higher income brackets while negatively affecting low-income, rice-producing households' food security. Results suggest that an agricultural policy with a view to support food security might have different, if not opposite, distributional impacts on targeted groups.

**Keywords:** food security, COVID-19, household-level analysis, demand estimation, rice policy, food policy, censored model, consumer economics

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## Introduction

Thailand food security is perceived by some to be tied to rice market conditions, as exemplified by the rice pledging scheme in 2011 and the COVID-19 pandemic in 2020. The food security impacts of rice policies and external shocks are complicated by the interactions of prices, income of rice-producing and other households, and household behaviors. Assessment is further complicated by the likelihood of greater concern about the food purchases of low-income households relative to others. In this paper, we describe how we developed and applied an empirical model that can address these complications and related the findings to the circumstances of the poorest households.

Thailand launched a rice policy in 2011 to support the domestic rice price by purchasing stocks partly in the name of food security, but this policy collapsed in 2014 and took the government with it (Permani and Vanzetti, 2016). This apparent failure might seem to run afoul of expectations that a stable food grain price policy could support economic development of farmers and contribute to stability more broadly (Addison, Ghoshray, and Stamatogiannis, 2016). This favorable view of price stabilizing policies might be reassessed by estimating the market effects of trade policy and state-trading that might be used to achieve price stability (Hoang and Meyers, 2015). Indeed, high food prices benefit net producers of food commodities but can negatively affect food security, especially in rural areas (Ferreira et al., 2013; Ha et al., 2015). Whatever the state of scientific investigation, price increases might be seen by policy makers as an element of or even a synonym for stabilizing prices, as the government of Thailand at that time seemed to believe, given the policy change.

The second shock to Thai rice markets, income, and food security is a global pandemic with and without the likely impacts of a hypothetical rice trade restriction. COVID-19 has introduced unprecedented effects on the global economy. Since the onset of the pandemic, the government of Thailand has taken various measures to contain the spread of the virus including lockdowns and curfews since March 2020. The food service and tourism industry were hard hit as restaurants and hotels closed, and international travel was banned (USDA-FAS, 2020). By July 2020, a number of fiscal policies and social protection measures had been issued by the Thai government in an attempt to mitigate the adverse impacts of the pandemic (Gentilini et al., 2020), which included record COVID-19 response packages totaling 12.9% of GDP (The World Bank, 2020). Rice farmers and the poorest households are presumably among the sociodemographic groups that are most vulnerable and hardest hit by this pandemic. To assess the trade-off of a policy that attempts to tame high staple prices, we examined a hypothetical trade restriction where the Thai government restricts its rice exports so as to halve the domestic rice price increase.

The focus of our study was to examine the confounding impacts of price and income change on the lowest-income households in Thailand. Deaton (1989) found evidence that rice price increases might favor middle-income households, not poor households, helping motivate scientists to estimate household-level impacts of commodity price increases. Studies have applied some elements of Deaton's framework to recent cases or married equilibrium model output to household-level indicators (OECD, 2007; Arndt et al., 2008; Coxhead, Linh, and Tam, 2012;

Badolo and Traoré, 2015). Household-level data have been widely used to measure the impacts of agricultural policies, often with a focus on household welfare impacts rather than consumption. For example, Balié, Minot, and Valera (2021) calculated the welfare impacts of the rice tariffication policy in the Philippines using the price change simulated by a partial equilibrium model together with expenditure and elasticities estimated from 2015 household survey data. Using 2008 household data for Côte d'Ivoire, Dimova and Gbakou (2013) concluded that a price increase is a welfare gain for poor rural households but a loss for middle-income urban households. Hasan (2017) found that a sharp rice price increase is a welfare loss for the poor in Bangladesh, but the impacts on poverty seem to lessen for households that are engaged in rice farming. In a cross-country study using household level data, Zezza et al. (2008) concluded that the poor are hardest hit by a price shock. In the case of Ethiopia particularly, Uregia, Desta, and Rashid (2012) also found that net-cereal sellers and some net-cereal buyers benefit from price shocks due to their ability to diversify to other foods and off-farm activities.

Some studies of household food expenditure data have attempted to either advance estimation and application methods with better techniques, in particular through censoring (Bilgic and Yen, 2014; Lazaro, Sam, and Thompson, 2017), using models to project future food demand (Valin et al., 2014) or measuring the impact of price and income shocks on household consumption and food security (Savadogo and Brandt, 1988; OECD, 2017; Hoang, 2018). Our study was able to combine the relevant innovations by accounting for censoring while analyzing the impacts on household-level consumption and food security.

In the present study, we estimated a censored demand system that represents Thai household food purchases as functions of price and total expenditures. We calculated how Thai rice price policies affected the prices and income, then estimated food quantity effects with a focus on households of the lowest income quintile. Our results relate directly to the impact of Thailand's rice policy and COVID-19 on food security of poor rice producers, poor consumers who do not sell rice, and others. A strength of this application is the ability to use the estimated economic parameters to conduct *a priori* analysis. The impacts of COVID-19 on household food security around the world are yet to be fully understood even though policy makers scrambled to respond to the pandemic as it took place; events outpaced scientific assessment in peer-reviewed articles. Here, we developed and applied an approach that can help the public understand the impacts of the pandemic on poor households that potentially face food insecurity.

The broader implications are clear. In terms of policy, evidence suggests that middle-income countries around the world tend to intervene in agricultural commodity markets if they can afford to do so (Anderson and Valenzuela, 2008; Anderson, Rausser, and Swinnen, 2013), at least some of which might be intended to improve food security. However, a justification for interventions that target prices on the grounds of improving food security is uncertain. Global food security policies that increase price support might be justified as a means to increase poor farmer income, yet they can diminish food security of other poor households for whom staple food consumption accounts for a substantial share of income. Our results highlight these trade-offs in an important case of a key country in the global rice market. The information is more widely useful for readers and policy makers who consider market interventions that change food commodity prices as a panacea for food security. We found no evidence that this direction of research and policy would result in easy answers to the challenges of food security.

The paper is organized as follows: Section 2 describes the data used, theory relating to censored demand system estimation, and scenario assumptions. Section 3 provides the estimated elasticities and simulation results. The last section discusses policy implications and concludes with some suggestions for future research.

## Estimation Strategy

### *Data and Method*

We used the public version of the Household Socio-Economic Survey (HSES) data conducted by the National Statistical Office of Thailand in 2014 for the analysis. HSES is a nationwide quantitative survey and is conducted on an annual basis. Delays in releasing HSES data cause studies that focused on Thailand to use samples that are nearly a decade old when the research article was published (Tiwasing, Dawson, and Garrod, 2018; Manajit, Samutachak, and Voelker, 2020; Wongmonta, 2020). While we used the latest data available to us, there is a risk that changes in preferences since then could affect our results. Our final sample included 42,670 households with detailed sociodemographic information, including whether a household is engaged in rice farming.

Unfortunately, this data set merged all cereal consumption into one aggregated group that includes rice, wheat, and other cereals; other foods were aggregated into 14 different groups. For this reason, it was impossible for us to know the exact rice consumption in each household. Rice, however, remains the dominant staple in Thailand (FAO, 2019). Therefore, we expected that changes in rice prices would be mirrored in cereal prices, and vice versa.

We regrouped food consumption into 6 broad groups: (i) cereals, (ii) meats, poultry, fish, and other seafood, (iii) vegetables, nuts, and fruits, (iv) milk, milk products, eggs, and sugar, (v) oils and fats, and (vi) food away from home (FAFH) and other miscellaneous foods. The sixth group includes the remaining food items, except for tobacco products. (These group names are sometimes abbreviated in subsequent text, tables, and figures to conserve space.) It should be noted that in our data set the cereal group only measures food-at-home (FAH) and excludes FAFH consumption due to the difficulty in extracting cereals from the FAFH aggregate.

We then added non-food consumption as a composite *numeraire* good to represent all other goods and services that a household consumed. Therefore, with this demand system, we allocated all expenditures, not just food expenditures, and elasticities were directly estimated. This demand system is supposed to provide unbiased measures of welfare and unconditional predictions of demand responses (Zhen et al., 2014).

The quadratic almost ideal demand system (QUAIDS) has a form as follows:

$$w_{ih} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij}\, lnp_j + \beta_i ln\left[\frac{m}{a(\boldsymbol{p})}\right] + \frac{\lambda_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{a(\boldsymbol{p})}\right]\right\}^2 + \varepsilon_{ih} \quad (1)$$

where $w_{ih}$ is the commodity $i$'s budget share of household $h$ derived from price, quantity and total expenditure, $w_i = p_i q_i / m$ and satisfies the constraint $\sum_{i=1}^{n} w_i = 1$, $n$ is the number of commodities in the system, $p_i$ is the price of commodity $i$, $m$ is per capita total expenditure; $a(\boldsymbol{p})$ and $b(\boldsymbol{p})$ are the price indices, $\boldsymbol{p}$ is the vector of prices; α, β, γ, and λ are parameters to be estimated; $\varepsilon_{ih}$ is a random error term.

Price indices are defined below:

$$lna(\boldsymbol{p}) = \alpha_0 + \sum_{n=1}^{n} \alpha_i\, lnp_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij}\, lnp_i\, lnp_j \quad (2)$$

$$b(\boldsymbol{p}) = \prod_{i=1}^{n} p_i^{\beta_i}\ . \quad (3)$$

All parameters need to satisfy the adding-up condition, homogeneity condition, and Slutsky symmetry restriction:

Adding-up: $\sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \beta_i = \sum_{i=1}^{n} \gamma_{ij} = 0,$

Homogeneity: $\sum_{i=1}^{n} \gamma_{ij} = 0\ \forall\ j,$

Symmetry: $\gamma_{ij} = \gamma_{ji}\ \forall\ i \neq j.$

The main focus of our study is cereal consumption among poor households, who spend a significant share of their income on staple foods. Fluctuations in the prices of cereals are expected to greatly affect these households' food security status. All else equal, an increase in income could give a household's food purchasing power a boost, though it is uncertain how income and price counteract if a household faces a trade-off between higher income and higher prices at the same time. This question is what our study attempted to answer.

Descriptive statistics of the food consumption, price, and sociodemographic variables used for the demand system estimation are presented in Table 1. Notably, more than 70% of households in the sample were engaged in agriculture, forestry, and fishing, of which 13% were engaged in rice farming activities. Using income per capita data, we divided the sample into quintiles with the lowest quintile representing households within the bottom 20% of the income distribution.

**Table 1.** Variable Definition and Sample Statistics (Sample Size = 42,670)

| Variable | Unit | Mean | Standard Deviation |
|---|---|---|---|
| Unit price-cereals | THB/kg | 34.6 | 9.4 |
| Unit price-meats and fish | THB/kg | 119.3 | 24.7 |
| Unit price-vegetables, fruits, and nuts | THB/kg | 52.6 | 21.0 |
| Unit price-milk and sugar | THB/kg | 78.5 | 34.9 |
| Unit price-oils and fats | THB/kg | 50.1 | 9.2 |
| Index price-others | Index | 109.0 | 43.0 |
| Index price-nonfood | Index | 0.4 | 0.1 |
| Income per capita | THB/kg | 70,880.5 | 45,023.7 |
| Size of the household | Person | 3.0 | 1.6 |
| Age of the HH head | Year | 53.6 | 14.8 |
| Number of kids 5 years old and younger | Person | 0.2 | 0.4 |
| Number of adults 60 years old and older | Person | 0.6 | 0.8 |
| Educational level of the household head | | | |
| Pre-primary or below | | 6% | |
| Primary | | 59% | |
| Secondary | | 21% | |
| Postsecondary | | 3% | |
| Bachelor's degree | | 9% | |
| Graduate study | | 2% | |
| Head of the household is male | | 38% | |
| Head of the household is married | | 32% | |
| Residing in urban areas | | 39% | |
| Engaged in agriculture, forestry and fishing | | 71% | |
| Engaged in rice farming activities | | 13% | |

Source: Authors' calculations using Thailand's Household Socioeconomic Survey 2014.

Table 2 presents budget shares and quantity consumed by income quintile. The lowest quintile households spent 10.4% of their budget on cereals, which is 5 times more than the highest quintile. Food, in general, accounts for more than half of the lowest quintile households' expenditures, whereas it is less than one-third for the highest income households. In terms of consumption, the poorest households consumed less food than other groups, although households of the second quintile actually had the highest level of cereal consumption. This is not surprising as cereals and grains are the basic food for poor and very poor households, whereas they may be inferior goods to those at higher income levels.

**Table 2.** Budget Share and Consumption by Income Quintile

| | **Full Sample** | **Lowest Quintile** | **Second Quintile** | **Middle Quintile** | **Fourth Quintile** | **Highest Quintile** |
|---|---|---|---|---|---|---|
| Budget share | | | | | | |
| Cereals | 6.4% | 10.4% | 7.2% | 5.3% | 3.5% | 2.0% |
| Meats and fish | 8.7% | 12.3% | 10.4% | 8.5% | 6.3% | 3.8% |
| Vegetables, fruits, and nuts | 5.4% | 6.4% | 5.9% | 5.2% | 4.2% | 3.0% |
| Milk and sugar | 3.8% | 4.6% | 3.9% | 3.3% | 2.7% | 1.8% |
| Oils and fats | 0.6% | 0.7% | 0.6% | 0.5% | 0.4% | 0.2% |
| FAFH and other foods | 18.3% | 14.4% | 15.9% | 16.9% | 18.0% | 16.8% |
| Nonfood | 56.9% | 46.3% | 51.4% | 56.2% | 61.5% | 70.9% |
| Quantity (kg/person)* | | | | | | |
| Cereals | 99.8 | 92.5 | 95.3 | 90.7 | 80.6 | 70.9 |
| Meats and fish | 41.8 | 30.3 | 38.7 | 41.4 | 41.3 | 41.1 |
| Vegetables, fruits, and nuts | 68.7 | 40.1 | 53.1 | 59.4 | 64.3 | 78.0 |
| Milk and sugar | 30.5 | 17.7 | 22.7 | 25.5 | 28.2 | 32.8 |
| Oils and fats | 6.5 | 4.0 | 5.2 | 6.0 | 6.0 | 6.0 |
| FAFH and other foods | 123.7 | 43.0 | 67.7 | 93.6 | 129.9 | 196.8 |
| Nonfood | 113.8 | 30.0 | 52.1 | 79.9 | 124.4 | 243.9 |

Source: Authors' calculations using Thailand's Household Socioeconomic Survey 2014. Quantity indices for FAFH and nonfood groups.

*Price Endogeneity and Censored Demand System*

Since unit prices are derived from expenditure and quantity, there is a possibility for an endogeneity issue due to the presence of total expenditure in the demand system. Following Hoang (2018), we impute the missing prices and correct the implied unit prices for quality variations using the communal mean price method. Unit price is first regressed on the mean unit price at the communal level, household budget share for food away from home, and a vector of household demographic variables. The residual from that equation was added to the communal mean unit price to obtain the quality-adjusted prices at the household level.

Like any other household data sets, we are not immune to the problem of households with zero expenditures (censoring). These households did not report consumption of one or more than one aggregated food groups. The highest rate of zero consumption in our data set is 9.7% (Table 3).

**Table 3.** Percentage of Zero Consumption for Each Group

| | **Non-consuming households (%)** |
|---|---|
| Cereals | 3.2 |
| Meats and fish | 9.7 |
| Vegetables, fruits, and nuts | 1.1 |
| Milk and sugar | 3.1 |
| Oils and fats | 8.6 |
| FAFH and other foods | 0.0 |
| Nonfood | 0.0 |

Source: Authors' calculations using Thailand's Household Socio-Economic Survey 2014.

Therefore, we followed Lazaro et al. (2017) to estimate a censored demand system using a 2-step approach. Although we had fewer incidence of zero expenditures than that study, perhaps owing to different levels of aggregation and scope of included goods, we are not aware of any lower bound Lazaro, Sam, and Thompson (2017) propose for the share of observations with zero expenditures. We can make a similar comparison to Dong, Gould, and Kaiser (2004) in that we have a smaller share of zero values in our data, but they also do not seem to set a threshold below which a censored demand is suspect. Yen, Lin, and Smallwood (2003) suggest not to use probit estimation if the share of zero expenditures in the sample falls below 5%. Two of the seven categories in this study exceed that threshold (Table 3). In a 2-step process, the first step involves a probit regression for each censored group. (In our case, we only estimated the first stage for the first five groups. The last two groups, FAFH and non-food, do not have the zero-expenditure problem). In the second step, we estimated a censored QUAIDS model using the first-step results and *nlsur* procedure in Stata version 14.2. Details of the probit estimation and demand equations are provided below.

At the first stage, we estimated the probability of a household *h* buying a commodity *i* by the probit model as follows:

$$d_{ih} = I(\boldsymbol{z}'_{\boldsymbol{ih}}\boldsymbol{\delta}_{\boldsymbol{i}} + v_{ih} > 0) \tag{4}$$

where $d_{ih}$ is a binary variable which is one if commodity *i* is consumed by household *h* and zero otherwise, $\boldsymbol{z}'_{\boldsymbol{ih}}$ is a vector of socio-demographic variables, $\boldsymbol{\delta}_{\boldsymbol{i}}$ is a vector of parameter for observable variables, and $v_{ih}$ is a normally distributed error term.

At the second stage, we estimated the commodity *i*'s budget share of household *h*, $w_{ih}$. Assume that the two error terms $\mathcal{E}_{ih}$ and $v_{ih}$ follow a bivariate normal distribution, $w_{ih}$ in the censored QUAIDS can be written as:

$$w_{ih} = \Phi(z'_{\boldsymbol{ih}}\delta_i)(\alpha_i + \sum_{j=1}^{n}\gamma_{ij}\, lnp_j + \beta_i ln\left[\frac{m}{a(\boldsymbol{p})}\right] + \frac{\lambda_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{a(\boldsymbol{p})}\right]\right\}^2 + \theta_{ih}\frac{\varphi(z'_{\boldsymbol{ih}}\delta_i)}{\Phi(z'_{\boldsymbol{ih}}\delta_i)}) + \zeta_{ih} \tag{5}$$

where $\zeta_{ih}$ is a commodity-specific error term with zero mean, and $\Phi(.)$ and $\varphi(.)$ are cumulative and standard normal density distribution functions, respectively. We calculated the inverse Mills ratio and used it as a weight in the demand estimation to correct for non-response households. The ratio is calculated as:

$\frac{\varphi(z'_{ih}\delta_i)}{\Phi(z'_{ih}\delta_i)}$, $i = 1$, ……, n.

We then computed uncompensated expenditure and price elasticities corresponding to the estimated parameters for the system of equations (2), (3), and (5) from the equations (6) and (7). The average expenditure elasticity of good $i$ across household $h$ is

$$\eta_i = 1 + \mathrm{E}(\frac{\Phi(z'_{ih}\hat{\delta}_i)}{\hat{w}_{ih}})(\beta_i + \frac{2\lambda_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{a(\boldsymbol{p})}\right]\right\}). \tag{6}$$

The average uncompensated price elasticity of good $i$ with respect to price of good $j$ across household $h$ is

$$e_{ij} = \mathrm{E}(\frac{\Phi(\boldsymbol{z'_{ih}}\hat{\boldsymbol{\delta}}_i)}{\hat{w}_{ih}})(\gamma_{ij} - (\beta_i + \frac{2\lambda_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{a(\boldsymbol{p})}\right]\right\})(\alpha_j + \textstyle\sum_{k=1}^{n}\gamma_{jk} ln p_k) - \frac{\lambda_i\beta_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{a(\boldsymbol{p})}\right]\right\}^2). \tag{7}$$

As for the omitted group, we followed Lazaro et al. (2017) to recover its expenditure elasticity and the remaining uncompensated elasticities using Engel and Cournot aggregations, i.e.

$\sum_{i=1}^{n} w_i\, e_{ij} = 1$, and

$\sum_{i=1}^{n} w_i\, e_{ij} + w_j = 0$ , respectively.

Finally, we computed bootstrapped standard errors from 50 replications of our data.

## Scenarios

We proposed two different scenarios to estimate the impacts of policy and market shocks on household food security. The first scenario reflected on the Thai government's pledging scheme in 2011. The second scenario analyzed the likely, directional impacts of the COVID-19 pandemic with and without market intervention to mitigate the rice price change.

We estimated baseline values by using the model to estimate demands at actual price and total expenditure values. By doing this, we eliminated any noises that came from the model's errors. An expected issue in shocking a demand system is that if the change in budget share for some groups is significantly large, the model may force budget shares to zero or below in order to preserve the adding-up condition (i.e., total budget shares must sum to 1). Fortunately, this issue tends to happen to households at the very high level of expenditure, which were not the main focus of our study.

*The Rice Pledging Scheme*

In 2011, the Thai government introduced the price support program (also called the price pledging scheme), which promised to pay Thai rice farmers twice the market price. This program was designed as a price support policy to help Thai farmers avoid selling their crops during the harvest seasons when prices tend to be low (USDA, FAS, 2017). When the program was discontinued in 2014, it had incurred a loss of about $21.5 billion in total, as the government bought rice at higher prices but later sold it at a much lower price, let alone other operating costs (Permani and Vanzetti, 2016). Whereas the country had been one of the largest exporters in the thinly traded world rice market, Thailand's rice exports also plummeted, causing the world price to increase significantly in 2011 (FAO, 2012).

To understand the extent of the Thai government's rice policy on rice prices and rice farmers' income, we rely on Permani and Vanzetti (2016) for their analysis of the impacts of the rice pledging scheme during the 2011–2013 period. Using a partial equilibrium model that reflects the global rice supply and demand dynamics, they estimated the welfare impacts of the rice policy based on three different scenario assumptions about price change and the government's stockholding schemes. The program, in general, is a welfare loss for the Thai consumers and a welfare gain for the Thai farmers. Among six different scenarios that were the combinations of the pledging scheme with and without stock purchase and stock sell-off, we chose Scenario B as our reference because, according to those authors, this scenario best reflects what implementation mechanisms the Thai government adopted in reality (Permani and Vanzetti, 2016, Table 5, p. 280). Scenario B assumes two actions: (i) rice farmers sell rice to the Thai government at the policy price that is set 50% above the market price, and (ii) the government buys 5 million tons of rice annually during this period. In this scenario, the domestic price increases from $567 per metric ton to $837, or by 48%. Consumer surplus decreases by $2.6 billion, and producer surplus increases by $5.8 billion.

Converting Scenario B results from Permani and Vanzetti (2016) to domestic currency, we estimated an increase of about 8.8 Thai bahts (THB) per kilogram of rice. We applied this fixed price increase as a proxy for the cereal price shock for all households. Using this fixed producer-to-consumer margin, we assumed that poor households experience a larger impact of the price shock, as the increase represents a larger percent of the base price.

Similarly, we divided the producer surplus by the number of rice farming households in Thailand (roughly 12 million farmers) to estimate the average change in net returns per household. Comparing the average effect on returns with the mean income of rice farming households in HSES, we estimated an increase of about 25% in income for rice-farming households as a result of the rice policy. Based on these calculations, we used two simulations to measure the impacts of the rice policy on Thai households.

We shocked the cereal price and total expenditure variables in the demand system, holding everything else constant. This condition also means that households react to the rice price increase by reallocating their food budget without changing their preferences for different types of foods.

We then compared the simulated quantity changes for each food group and by each quintile with the corresponding base values.

*The COVID-19 Pandemic and a Hypothetical Trade Policy*

The wholesale prices of rice in Thailand increased by 7.8% on a year-over-year basis as the pandemic took hold (Bank of Thailand, 2021). In addition, the Thai economy contracted by 7.1% in 2020 (IMF, 2021). Little is known about the true effects of the pandemic on food markets, consumers, producers, and the economy as a whole. Nevertheless, we based our hypothetical assumptions on this information about price and income. Adding to the complexity of COVID-19, we tested the implications in the event that the Thai government were to intervene in the market to reduce the rice price increase by half. This hypothetical policy case might reflect some combination of rice export restrictions and renewed stock holding.

Scenario assumptions for the pandemic impacts without a rice policy response call for a 7.8% increase in rice price and a 7.1% reduction in household expenditures overall, with rice-producing household expenditures rising by 7.0% on average (Table 4). We assumed a direct link from income changes to total expenditure changes. For rice-producing household total expenditures, we relied on estimates of the rice-pledging policy effect on the income of these households, as given earlier, and assumed that a change in rice prices would have a similar impact on rice farmers' income on average. Thus, we calculated a conversion factor that is the percent change in rice-producing household per percent change in rice prices. The average value of the conversion factor is 0.9, which means that if rice prices increase by 1%, then we expect that rice farmers' income (and expenditures) would increase by 0.9%. Since we calculated this at the household level and based this relationship on the information of the earlier policy scenario, each household's conversion factor is slightly different.

**Table 4.** COVID-19 and Policy Assumptions

| | **COVID-19 without Trade Policy Response** | **COVID-19 with Trade Policy Response** |
|---|---|---|
| Rice price | +7.8% | +3.9% |
| Income of all households including rice farming households | -7.1% | -7.1% |
| Income of households that are engaged in rice farming | +7.0% | +3.5% |

Source: Authors' calculations.

# Results

*First- and Second-Stage Estimation Results*

Table 5 reports parameter estimates with bootstrapped standard errors. Table 6 presents the own-price and expenditure elasticity estimates for the lowest income quintile. Full elasticity estimates are provided in Table 7. All estimates are reported at their median values. For brevity, we focus our discussion on the results for low-income households in Table 6. We find that except for nonfood, all other goods, meaning all foods, are inelastic with regard to their own price with magnitudes ranging from −0.60 to −0.82. The total expenditure elasticity for cereals is very inelastic (0.06) but positive. Animal product groups, including meats, fish, oils, and fats, are less inelastic with respect to total expenditure than cereals, milk, and sugar. FAFH and nonfood total expenditure elasticities are larger than 1. If total expenditure elasticities are considered proxies for income elasticities, our results are consistent with past findings that low-income households' basic cereals demand is relatively inelastic with respect to income, while their FAFH and nonfood demands are relatively elastic.

*Scenario Results*

Impacts of the Rice Pledging Scheme

We applied three simulations to compare the impacts of price and income effects in this scenario compared to the base case. Simulation 1 assumes cereal prices increase by 8.8 THB per kilogram for all households in the sample. Simulation 2 assumes rice farmers' income increases by 25%. Simulation 3 combines both simulations 1 and 2. Table 8 shows the results for our focus group—the lowest income quintile. In Simulation 1, which only accounts for an increase in cereal prices, households increase their budget share for cereals by 0.84 percentage points on average in response to higher staple prices while reducing their budgets for meats and fish, FAFH, and especially nonfood items. In terms of quantity, households reduce their food consumption overall. Cereal consumption is hardest hit with a decrease by 16.3%, as the increase in budget share (as well as expenditure) is insufficient to offset the increase in cereal prices.

In Simulation 2, which assumes an increase in rice farmers' income, the budget shares for FAFH and nonfood increase while those of other groups slightly decrease. It should be noted that food expenditures still increase in absolute terms for those with decreased budget shares since the increase in income more than offsets the percent decrease in the share. What we observe is an increase in consumption overall.

**Table 5.** Nonlinear AIDS Parameter Estimate

| Category | Cereals | Meats and Fish | Vegetables, Fruits, and Nuts | Milk and Sugar | Oils and Fats | FAFH and Other Foods |
|---|---|---|---|---|---|---|
| γ (price coefficient) | | | | | | |
| Cereals | 0.0055*** | | | | | |
| | (0.0011) | | | | | |
| Meats and fish | -0.0146*** | 0.0334*** | | | | |
| | (0.0010) | (0.0012) | | | | |
| Vegetables, fruits, and nuts | -0.0026*** | -0.0026*** | 0.0120*** | | | |
| | (0.0007) | (0.0005) | (0.0003) | | | |
| Milk and sugar | -0.0100*** | -0.0081*** | -0.0028*** | 0.0159*** | | |
| | (0.0006) | (0.0005) | (0.0002) | (0.0004) | | |
| Oils and fats | -0.0014*** | -0.0007*** | 0.0005*** | -0.0008*** | 0.0034*** | |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | |
| FAFH and other foods | -0.0016 | -0.0186*** | -0.0111*** | -0.0031*** | -0.0010*** | 0.0640*** |
| | (0.0012) | (0.0007) | (0.0005) | (0.0006) | (0.0001) | (0.0017) |
| α | 0.4381*** | 0.2222*** | 0.1331*** | 0.1633*** | 0.0125*** | -0.0871*** |
| | (0.0066) | (0.0092) | (0.0056) | (0.0051) | (0.0011) | (0.0103) |
| *β* (expenditure coefficient) | -0.1142*** | -0.0145*** | -0.0047* | -0.0353*** | -0.0006 | 0.0724*** |
| | (0.0025) | (0.0046) | (0.0026) | (0.0021) | (0.0004) | (0.0057) |
| *λ* (squared expenditure coefficient) | 0.0065*** | -0.0052*** | -0.0021*** | 0.0019*** | -0.0004*** | -0.0083*** |
| | (0.0003) | (0.0006) | (0.0003) | (0.0002) | (0.0000) | (0.0008) |
| *θ* (inverse Mills ratios) | 0.0901*** | 0.0718*** | 0.0806*** | -0.0856*** | 0.0062*** | |
| | (0.0024) | (0.0024) | (0.0048) | (0.0024) | (0.0002) | |

Note: Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. Bootstrapped standard errors (in parentheses) are reported instead of standard errors generated from the observed data. Source: Authors' calculations.

**Table 6.** Uncompensated Price and Expenditure Elasticity Estimates for the Lowest Quintile

| | **Cereals** | **Meats and Fish** | **Vegetables, Fruits, and Nuts** | **Milk and Sugar** | **Oils and Fats** | **FAFH and Other Foods** | **Nonfood** | **Expenditure Elasticity** |
|---|---|---|---|---|---|---|---|---|
| Cereals | -0.6258*** | 0.0649*** | 0.0734*** | 0.0386*** | -0.0008 | 0.0628*** | 0.4515*** | 0.0636*** |
| | (0.0059) | (0.0079) | (0.0043) | (0.0046) | (0.0009) | (0.0060) | (0.0115) | (0.0206) |
| Meats and fish | -0.0787*** | -0.7221*** | -0.0099* | -0.0487*** | -0.0040*** | -0.1350*** | 0.1092*** | 0.8889*** |
| | (0.0077) | (0.0098) | (0.0051) | (0.0035) | (0.0011) | (0.0070) | (0.0112) | (0.0296) |
| Vegetables, fruits, and nuts | -0.0169** | -0.0248*** | -0.8217*** | -0.0325*** | 0.0077*** | -0.1539*** | 0.1092*** | 0.9328*** |
| | (0.0068) | (0.0088) | (0.0053) | (0.0043) | (0.0012) | (0.0081) | (0.0121) | (0.0312) |
| Milk and sugar | 0.0125 | -0.0248* | 0.0069 | -0.6511*** | -0.0066** | -0.0079 | 0.2792** | 0.3933 |
| | (0.0127) | (0.0133) | (0.0066) | (0.1532) | (0.0031) | (0.0231) | (0.1293) | (0.3035) |
| Oils and fats | -0.1460*** | -0.0681*** | 0.0631*** | -0.0848*** | -0.5997*** | -0.1148*** | 0.0171 | 0.9331*** |
| | (0.0123) | (0.0179) | (0.0102) | (0.0077) | (0.0159) | (0.0128) | (0.0223) | (0.0479) |
| FAFH and other foods | -0.1374 | -0.1890 | -0.1036 | -0.0704 | -0.0108 | -0.6571 | -0.2550 | 1.4231 |
| | (0.3346) | (0.4919) | (0.2642) | (0.1770) | (0.0283) | (0.9924) | (0.6684) | (0.9720) |
| Nonfood | 0.0175 | -0.0046 | 0.0018 | -0.0034 | -0.0026 | -0.0708 | -1.0489*** | 1.0498*** |
| | (0.1216) | (0.1788) | (0.0959) | (0.0666) | (0.0103) | (0.3612) | (0.2420) | (0.0143) |

Note: Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. Bootstrapped standard errors (in parentheses) are reported instead of standard errors generated from the observed data. Source: Authors' calculations.

**Table 7.** Uncompensated Expenditure and Price Elasticity Estimates

| | **Cereals** | **Meats and Fish** | **Vegetables, Fruits, and Nuts** | **Milk and Sugar** | **Oils and Fats** | **FAFH and Other Foods** | **Nonfood** | **Expenditure Elasticity** |
|---|---|---|---|---|---|---|---|---|
| Cereals | -0.3812 | 0.1041 | 0.1205 | 0.0598 | -0.0017 | 0.1177 | 0.7500 | -0.7732 |
| | (2.5597) | (0.3062) | (0.4990) | (0.2529) | (0.0196) | (0.8002) | (3.0943) | (7.4880) |
| Meats and fish | -0.1046** | -0.6322*** | -0.0133 | -0.0648** | -0.0053*** | -0.1773*** | 0.1400** | 0.8527*** |
| | (0.0416) | (0.1365) | (0.0093) | (0.0275) | (0.0028) | (0.0679) | (0.0630) | (0.0776) |
| Vegetables, fruits and nuts | -0.0215** | -0.0315** | -0.7749*** | -0.0412*** | 0.0097*** | -0.1936*** | 0.1400*** | 0.9151*** |
| | (0.0099) | (0.013) | (0.0483) | (0.0088) | (0.0031) | (0.0407) | (0.0403) | (0.0546) |
| Milk and sugar | 0.0157 | -0.0391 | 0.0089 | -0.4889 | -0.0098 | -0.0058 | 0.4100 | 0.1087 |
| | (0.4295) | (0.2745) | (0.1756) | (0.2628) | (1.1977) | (0.3320) | (0.0613) | (0.1276) |
| Oils and fats | -0.1936 | -0.0905 | 0.0835 | -0.1126 | -0.4698 | -0.1513 | 0.0200 | 0.9114*** |
| | (0.1281) | (0.0630) | (0.0681) | (0.0808) | (0.3758) | (0.1154) | (0.0613) | (0.1099) |
| FAFH and other foods | -0.1271* | -0.1748* | -0.0961* | -0.0646* | -0.0099*** | -0.6832* | -0.2400 | 1.3940*** |
| | (0.0671) | (0.0987) | (0.0533) | (0.0353) | (0.0057) | (0.198) | (0.1349) | (0.1982) |
| Nonfood | 0.0175 | -0.0046 | 0.0018 | -0.0033 | -0.0026 | -0.0708 | -1.0500*** | 1.1701*** |
| | (0.2891) | (0.0499) | (0.0584) | (0.157) | (0.0128) | (0.1148) | (0.3828) | (0.0122) |

Note: Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. Bootstrapped standard errors (in parentheses) are reported instead of standard errors generated from the observed data. Source: Authors' calculations.

**Table 8.** Impacts of the Rice Pledging Policy on the Lowest Income Quintile

| | | Base | Simulation 1 | Simulation 2 | Simulation 3 | Simulation 1 | Simulation 2 | Simulation 3 |
|---|---|---|---|---|---|---|---|---|
| Budget share | | | | | | | Percentage point change | |
| Cereals | Percent | 10.6 | 11.5 | 10.3 | 11.1 | 0.84 | -0.37 | 0.48 |
| Meats and fish | Percent | 12.7 | 12.6 | 12.4 | 12.3 | -0.11 | -0.24 | -0.35 |
| Vegetables, fruits, and nuts | Percent | 6.9 | 7.0 | 6.9 | 6.9 | 0.03 | -0.09 | -0.06 |
| Milk and sugar | Percent | 5.7 | 5.7 | 5.6 | 5.5 | -0.04 | -0.13 | -0.17 |
| Oils and fats | Percent | 0.8 | 0.8 | 0.8 | 0.8 | -0.02 | -0.02 | -0.04 |
| FAFH and other foods | Percent | 17.1 | 16.7 | 17.2 | 16.6 | -0.37 | 0.08 | -0.53 |
| Nonfood | Percent | 46.4 | 46.0 | 47.1 | 47.0 | -0.35 | 0.71 | 0.60 |
| Quantity | | | | | | | Percent change | |
| Cereals | kg/person | 97.0 | 81.2 | 98.7 | 82.8 | -16.3% | 1.7% | -14.7% |
| Meats and fish | kg/person | 31.8 | 31.5 | 32.8 | 32.5 | -0.9% | 3.1% | 2.2% |
| Vegetables, fruits, and nuts | kg/person | 43.0 | 43.2 | 44.9 | 45.1 | 0.5% | 4.3% | 4.8% |
| Milk and sugar | kg/person | 21.6 | 21.4 | 22.2 | 22.1 | -0.6% | 3.2% | 2.5% |
| Oils and fats | kg/person | 4.6 | 4.5 | 4.8 | 4.7 | -2.6% | 3.1% | 0.4% |
| FAFH and other foods | Index | 52.3 | 51.1 | 55.5 | 53.5 | -2.2% | 6.1% | 2.3% |
| Nonfood | Index | 30.5 | 30.3 | 32.6 | 32.6 | -0.7% | 6.8% | 6.6% |

Note: Simulation 1 assumes cereal prices increase by 8.8 THB per kilogram for all households in the sample. Simulation 2 assumes rice farmers' income and total expenditures increase by 25%. Simulation 3 combines both Simulations 1 and 2. Source: Authors' calculations.

Combining both negative price and positive income effects, we observed that households in the poorest quintile respond by increasing their budget for cereals, though this is not enough to offset the increase in prices. Cereal consumption, thus, reduces by 14.7% on average. Rice-producing households, which account for about 1 in every 4 households in this income bracket, also reduce their cereal consumption but to a lesser extent due to the offsetting income effect induced by the policy. Overall, the impacts on other categories of food and nonfood consumption are positive but smaller in absolute terms than in Simulation 2.

Impacts of COVID-19 and a Hypothetical Trade Policy

The first set of results estimates the impacts without any trade policy response (Table 9). Overall, higher cereal prices coupled with a decline in income cause low-income households to reduce their overall consumption, with the largest changes being FAFH (7.3%), followed by nonfood (7.1%) and cereals (6.8%). Comparing results for rice-farming and non-rice-farming households of the lowest income bracket, we found that those who are not engaged in rice farming are harder hit by the price increase because they do not benefit from the income boost induced by a higher price (Table 10). For both types of households in this income bracket, cereal consumption quantity is reduced at the higher price, but the greater value of rice sales mitigates some of this drop for rice-producing households. For such households, however, a large part of the income increase appears to go to buy non-cereal items, and the income effect in this case is more apparent when comparing quantities of other goods that they buy relative to the quantities purchased by low-income households that do not benefit from higher valued rice sales.

Adding a hypothetical trade response policy that cuts rice prices by half, we first compared the impacts on consumption across income quintile (Table 11). All else equal, such a trade policy increases cereal consumption for all households, with the largest impact on the lowest income households. On the flip side, a lower rice price means lower income for rice-farming households, which account for about a quarter of the lowest quintile and about one-fifth of the second lowest quintile. The negative income effects induce some decreases in consumption of other goods for these households. Households in the higher income ranks tend to benefit from the trade response overall.

**Table 9.** Impacts of COVID-19 without Trade Policy Response on the Lowest Income Quintile

| | | **Base** | **Simulation 1** | **Simulation 2** | **Simulation 3** | **Simulation 1** | **Simulation 2** | **Simulation 3** |
|---|---|---|---|---|---|---|---|---|
| Budget share | | | | | | Percentage point change | | |
| Cereals | Percent | 10.6 | 10.9 | 11.0 | 11.3 | 0.3 | 0.4 | 0.7 |
| Meats and fish | Percent | 12.7 | 12.6 | 12.9 | 12.9 | -0.1 | 0.2 | 0.2 |
| Vegetables, fruits, and nuts | Percent | 6.9 | 7.0 | 7.0 | 7.1 | 0.1 | 0.1 | 0.2 |
| Milk and sugar | Percent | 5.7 | 5.7 | 5.8 | 5.8 | 0.0 | 0.1 | 0.1 |
| Oils and fats | Percent | 0.8 | 0.8 | 0.8 | 0.8 | 0.0 | 0.0 | 0.0 |
| FAFH and other foods | Percent | 17.1 | 17.0 | 17.0 | 16.8 | -0.1 | -0.1 | -0.3 |
| Nonfood | Percent | 46.4 | 46.3 | 45.5 | 45.5 | -0.1 | -0.9 | -0.9 |
| Quantity | | | | | | Percent change | | |
| Cereals | kg/person | 97.0 | 92.1 | 95.4 | 90.4 | -5.0% | -1.7% | -6.8% |
| Meats and fish | kg/person | 31.8 | 31.7 | 30.7 | 30.6 | -0.3% | -3.6% | -3.8% |
| Vegetables, fruits, and nuts | kg/person | 43.0 | 43.1 | 41.3 | 41.3 | 0.1% | -4.1% | -4.0% |
| Milk and sugar | kg/person | 21.6 | 21.5 | 20.9 | 20.9 | -0.2% | -3.1% | -3.2% |
| Oils and fats | kg/person | 4.6 | 4.6 | 4.5 | 4.4 | -0.7% | -3.7% | -4.4% |
| FAFH and other foods | Index | 52.3 | 51.9 | 49.0 | 48.5 | -0.7% | -6.3% | -7.3% |
| Nonfood | Index | 30.5 | 30.5 | 28.4 | 28.4 | -0.2% | -7.1% | -7.1% |

Note: Simulation 1 assumes cereal prices increase by 7.8%. Simulation 2 assumes rice farming household income and total expenditure decrease by 7.1%. Simulation 3 combines both Simulations 1 and 2. Source: Authors' calculations.

**Table 10.** Impacts of COVID-19 without Trade Policy Response on Rice- and Non-Rice-Farming Groups

| | | Rice-Farming and Poor | | | Non-Rice-Farming and Poor | | |
|---|---|---|---|---|---|---|---|
| **Quantity** | | **Base** | **COVID-19 Scenario** | | **Base** | **COVID-19 Scenario** | |
| | | | | Change from base | | | Change from base |
| Cereals | kg/person | 96.4 | 91.3 | -5.3% | 97.25 | 90.2 | -7.3% |
| Meats and fish | kg/person | 32.0 | 31.8 | -0.7% | 31.73 | 30.2 | -4.9% |
| Vegetables, fruits, and nuts | kg/person | 45.2 | 45.0 | -0.4% | 42.3 | 40.1 | -5.3% |
| Milk and sugar | kg/person | 21.3 | 21.2 | -0.7% | 21.66 | 20.7 | -4.3% |
| Oils and fats | kg/person | 4.6 | 4.5 | -1.9% | 4.651 | 4.4 | -5.5% |
| FAFH and other food | Index | 52.4 | 51.5 | -1.7% | 52.14 | 47.5 | -8.9% |
| Nonfood | Index | 29.8 | 29.6 | -0.9% | 30.73 | 27.9 | -9.2% |
| Number of households | | 2,157 | | | 6,377 | | |

Source: Authors' calculations.

**Table 11.** Impacts of a Trade Response in the Event of COVID-19 by Income Quintile

| Food Group | Unit | Quintile 1 | Quintile 2 | Quintile 3 | Quintile 4 | Quintile 5 |
|---|---|---|---|---|---|---|
| Cereals | kg/person | 2.3% | 2.2% | 1.9% | 1.4% | 0.04% |
| Meats and fish | kg/person | -0.3% | -0.1% | 0.0% | 0.1% | 0.3% |
| Vegetables, fruits, and nuts | kg/person | -0.6% | -0.5% | -0.3% | -0.2% | -0.1% |
| Milk and sugar | kg/person | -0.5% | -0.2% | 0.0% | 0.2% | 0.2% |
| Oils and fats | kg/person | -0.2% | 0.1% | 0.3% | 0.5% | 0.9% |
| FAFH and other food | Index | -0.2% | -0.2% | 0.1% | 0.3% | 0.4% |
| Nonfood | Index | -1.2% | -0.6% | -0.5% | -0.3% | -0.2% |

Source: Authors' calculations.

The impacts on rice-farming households' food consumption, in particular, is presented in Figure 1. As said, due to the dual nature of being both rice producers and consumers, the market intervention has as a negative effect on rice-producing household income relative to COVID without a trade policy response. The net effect of the pandemic on trade policy response for rice-farming households is a rice price that the limited income growth is insufficient to offset, as before, if judged in terms of cereal consumption alone. However, some of the potentially important effects are seen in negative spill-overs of the trade policy response to other goods caused by the combination of income and cross-price effect, with larger reduction in non-cereal consumption, especially nonfood items, compared to the COVID pandemic without trade policy response.

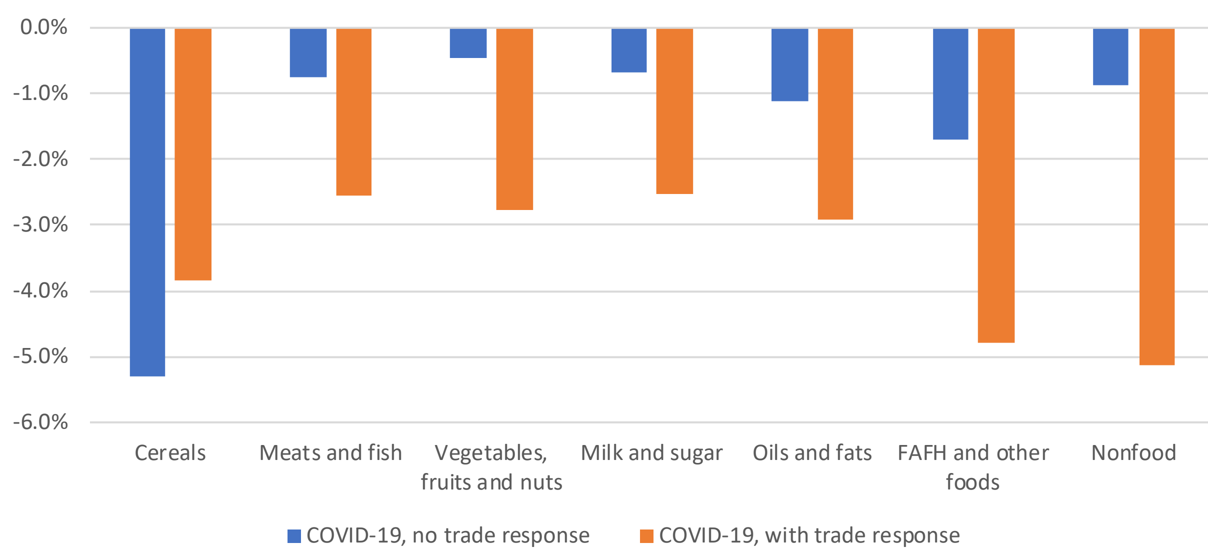


**Figure 1.** Changes in Consumption by the Lowest Income Households that Are Engaged in Rice Farming

## Policy Implications and Conclusions

Evidence suggests that middle-income and developing countries turn to agricultural commodity market interventions as a policy instrument to achieve policy goals (Anderson and Valenzuela, 2008; Anderson et al., 2013), presumably including improving food security and managing crises when budget constraints limit other policy options. One outcome of the price surge of the last decade was a newfound reliance by many countries on direct intervention to constrain the market price increases in the name of food security (Demeke, Pangrazio, and Maetz, 2009). Taking Thailand as a case study, we used Thai household data to estimate food demands, adjust prices and expenditures to represent the impacts of the rice market interventions, and quantify the impacts, particularly on rice-producing households and poor households.

Thailand's rice pledging policy is recognized as an important case. This major rice-producing country introduced a policy to increase rice prices through stock-buying. The program resulted in higher income to rice producers and higher domestic prices to rice consumers. Consumers respond to the higher price by decreasing grain purchases. To some extent, the price impact is offset by a combination of reduced consumption of some foods to free up funds to buy higher priced grains and increased consumption of substitute foods. The net effect is a 14.7% decrease in cereal consumption on average for households whose income is not affected by the policy experiencing a negative impact on their food security overall.

We applied our method to estimate how income and price impacts suggested by Thailand's experience during the COVID-19 pandemic affect food security along this same dimension, to which we added an experiment to test the impacts of a hypothetical trade policy response. By exploiting our household representation and estimated market and income effects, we estimated selected pandemic price and income impacts on the poorest households of the country. These households try to preserve cereal consumption despite the income and price impacts of the pandemic, but still lose almost 7% of consumption, or about 24 days of cereal use in a year. This focus on maintaining staple consumption comes at the expense of other foods, with low-income households sacrificing 3%-7% of other foods, or 12 to 27 days' worth of use. A hypothetical trade measure that attempts to halve the domestic cereal price increase during the pandemic helps mitigate the impacts on many households while adversely affecting poor rice farming households' food security. Owing to the combination of price sensitivity, income sensitivity, and sizes of price and income effects of the trade measure, rice-producing households' food security is negatively affected to a larger extent relative to the impact of COVID-19 without a trade policy.

This study did not speak to all dimensions of food security, all policy makers' concerns, or all aspects of a pandemic, of course. It would require additional research to investigate intra-household consumption patterns or intra-annual price and income variations, to give two important examples. Pandemic impacts observed in 2020 go well beyond income and price shocks. Nevertheless, policy makers who have turned to agricultural policy with a view to support food security might do so again during the pandemic without waiting for a scientific study to provide information. For the case studied here and other countries that are in similar circumstances, namely looking for quick options to address a crisis yet perhaps with limited options apart from commodity trade or stock policies, our results are germane. The method and findings of the work above demonstrate the interactions of price-based policies and shocks with income effects in terms of their impacts on food consumption and security of the poorest households. Such findings can speak to certain outcomes of policy mechanisms during a crisis as severe as a global pandemic or as commonplace as widely used agricultural policy instruments.

## Acknowledgement

We thank the reviewers and editor for useful comments and suggestions that helped improve the contents and exposition of this paper. This material is based upon work supported by the U.S. Department of Agriculture, under Agreement No. 58-0111-20-016 and the USDA National Institute of Food and Agriculture, Hatch project number MOC1537173. All remaining errors, the findings, and any opinions expressed here are our own.

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